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PATENT ABSTRACTS OF JAPAN

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(71)Applicant : SHARP CORP

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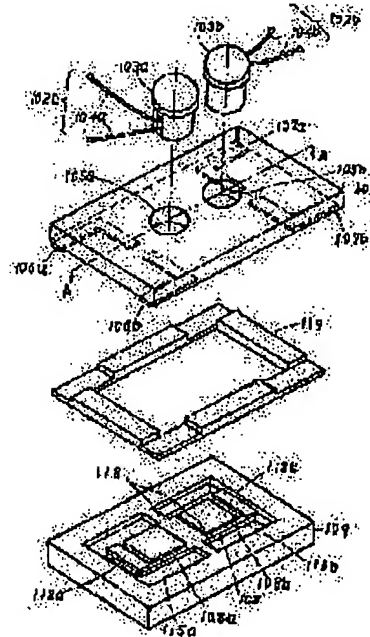
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(54) ELECTROMAGNETIC RELAY

(57)Abstract:

PURPOSE: To provide a micro-relay whose driving force is great by making up mechanical elements of an electromagnetic magnet provided for a substrate and of a semi-conductor disposed opposite to the magnet, and concurrently furnishing them with each stationary and each movable contact layer respectively.

CONSTITUTION: There are provided both electromagnetic magnets 102a and 102b which generate magnetic motive force acting as driving source, and sucking sections 115a and 115b made of magnetic substance formed over movable pieces 108a and 108b which are provided for a ceramic substrate 101 supporting the aforesaid magnets via a spacer 119. When DC voltage is applied to the magnets 102a and 102b, the sucking sections 115a and 115b are sucked up while movable pieces 108a and 108b are being deflected by magnet motive force. And stationary contact layers 106a and 106b, 107a and 107b formed in the main surface of a substrate 101, can thereby be opened/closed by means of movable contact layers 112a and 112b separately formed in the aforesaid movable pieces.



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CLAIMS

[Claim(s)]

[Claim 1] A machine element is constituted from an electromagnetic magnet prepared in the substrate of an electric insulator, and a movable piece which becomes this substrate principal plane that prepared the above-mentioned electromagnetic magnet from the semi-conductor single crystal by which opposite arrangement was carried out through the spacer means, and which carries out movable. The adsorption section formed in the front face of the above-mentioned movable piece which counters the above-mentioned electromagnetic magnet with the magnetic substance, The electromagnetic relay characterized by having the traveling contact layer formed in the above-mentioned movable piece through the insulating thin film, and the stationary-contact layer which are formed in the principal plane of the substrate of the above-mentioned electric insulator, and are opened and closed in the above-mentioned traveling contact layer.

[Claim 2] The electromagnetic relay according to claim 1 characterized by coming to lay a detailed coil underground between the above-mentioned movable piece and the above-mentioned adsorption section.

[Claim 3] The above-mentioned adsorption section is an electromagnetic relay according to claim 1 characterized by being formed using a magnet.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention is one of the micro machines, and relates to the electromagnetic relay which makes magnetomotive force a driving source.

[0002]

[Description of the Prior Art] One of the micro machines has conventionally the electrostatic relay which makes an electrostatic suction force a driving source.

[0003] This electrostatic relay is indicated by JP,2-100224,A as an example. Drawing 14 is the decomposition perspective view of the conventional electrostatic relay. Drawing 15 is the A-A line sectional view of drawing 14.

[0004] Actuation of this electrostatic relay is explained. If direct current voltage is impressed between the movable piece 911 and the fixed electrode layer 902 by the side of before, an electrostatic suction force will occur between piece section of before movable piece 911 911A, and the above-mentioned electrode layer 902, piece section of before 911A uses the pivotable support section 912 as the supporting point, in order to distort and displace to the electrode layer 902 side, the traveling contact layer 914 will contact the stationary-contact layer 904,905, and between both the stationary-contacts layers 904,905 will be closed. If impression of the above-mentioned direct current voltage is severed, movable piece 911A will return to the original state by the torsion return force of the pivotable support section 912, and between both the stationary-contacts layers 904,905 will be opened wide.

[0005] By impressing direct current voltage between the movable piece 911 and the fixed electrode layer 903 on the backside, piece section of after movable piece 911 911B also performs the same actuation as the above.

[0006] Here, micro processing will become possible if the movable piece 911 is formed from the silicon single crystal wafer 908. Furthermore, since the above-mentioned movable piece 911 was formed from the silicon single crystal wafer 908 of another object in the base 901, by selection of a spacer 909, inter-electrode distance can be changed and desired driving force can be obtained.

[0007]

[Problem(s) to be Solved by the Invention] However, the above-mentioned traveling contact layer 914 contacts the above-mentioned stationary-contact layer 904,905, and it is required of the electrostatic relay by micro processing raised to above-mentioned drawing 14 to make an electrostatic predetermined suction force occur between the counterelectrodes for a drive which constituted between both the stationary-contacts layers 904,905 from an above-mentioned fixed electrode layer 902,903 and an above-mentioned movable piece 911 in order to carry out ON and OFF control. Moreover, since there is a danger of connecting too hastily if this clearance is made small very much, although it is necessary to make small the above-mentioned inter-electrode clearance which counters, it is unproducible in below the magnitude of actual condition specification.

[0008] Then, the purpose of this invention is by making into a driving source magnetomotive force which happens by impressing direct current voltage to an electromagnetic magnet to offer the micro relay with which bigger driving force than the conventional micro relay is obtained.

[0009]

[Means for Solving the Problem] The electromagnetic relay which relates to claim 1 of this invention in order to attain said purpose A machine element is constituted from an electromagnetic magnet prepared in the substrate of an electric insulator, and a movable piece which becomes this substrate principal plane that prepared the above-mentioned electromagnetic magnet from the semi-conductor single crystal by which opposite arrangement was carried out through the spacer means, and which carries out movable. It is characterized by having the adsorption section formed in the front face of the above-mentioned movable piece which counters the above-mentioned electromagnetic magnet with the magnetic substance, the traveling contact layer formed in the above-mentioned movable piece through the insulating thin film, and the stationary-contact layer which are formed in the principal plane of the substrate of the above-mentioned electric insulator, and are opened and closed in the above-mentioned traveling contact layer. The electromagnetic relay concerning claim 2 is characterized by coming

to lay a detailed coil underground between the above-mentioned movable piece and the above-mentioned adsorption section. The electromagnetic relay concerning claim 3 is characterized by having used the magnet for the above-mentioned adsorption section, and being formed in it.

[0010]

[Function] According to the configuration of claim 1 of this invention, the adsorption section formed in the front face of the movable piece which was countered and arranged in the ***** substrate principal plane in the electromagnetic magnet with which the magnetomotive force used as a driving source occurs, and this electromagnetic magnet, and which carries out movable with the magnetic substance is prepared. The above-mentioned movable piece is sagged with the magnetomotive force which happens by impressing direct current voltage to the above-mentioned electromagnetic magnet, and the above-mentioned movable piece is adsorbed at the above-mentioned electromagnetic magnet. Then, the stationary-contact layer formed in the above-mentioned substrate principal plane in the traveling contact layer separately formed in the above-mentioned movable piece can be opened and closed.

[0011] According to the configuration of claim 2 of this invention, a detailed coil is laid underground between the above-mentioned movable piece and the above-mentioned adsorption section by special processing. Although remnant magnetism remains in the above-mentioned adsorption section slightly after impressing and disconnecting direct current voltage to the above-mentioned electromagnetic magnet, direct current voltage can be temporarily impressed to the above-mentioned coil laid under the above-mentioned movable piece, and the remnant magnetism of the above-mentioned adsorption section can be removed.

[0012] According to the configuration of claim 3 of this invention, the above-mentioned adsorption section is formed using a magnet. If direct current voltage is always impressed to the above-mentioned electromagnetic magnet, this electromagnetic magnet can be used as an electromagnet. The polarity (N pole and south pole) of the above-mentioned electromagnetic magnet can be changed by changing the sense of the current passed in the coil of the above-mentioned electromagnetic magnet. Then, a movable piece can be adsorbed or the above-mentioned electromagnetic magnet can be opposed.

[0013]

[Example] One example of this invention is explained with reference to a drawing. Drawing 1 is the decomposition perspective view of an electromagnetic relay of the 1st example. Drawing 2 is the A-A line sectional view of drawing 1. Drawing 3 is drawing having shown the creation approach of ceramic substrate side 101 gradually, and drawing 4 is the expanded sectional view of electromagnetic magnet 102a made to insert in the through hole of the ceramic substrate 101 of drawing 3.

[0014] The electromagnetic magnets 102a and 102b consist of Cores 103a and 103b and Coils (copper wire) 104a and 104b. Cores 103a and 103b are created by making for example, a Mn (manganese)-Zn (zinc) ferrite into fine particles, putting into metal mold, hardening, and calcinating, and Coils 104a and 104b roll the about 30-turn surroundings at a time with the 0.1mm copper wire covered with the insulating material around the heart in Cores 103a and 103b, and they create.

[0015] A ceramic substrate 101 is created by putting the fine particles of aluminum 2O3 (alumina) into metal mold, hardening them, and calcinating them. Through holes 105a and 105b are formed in the ceramic substrate 101 (drawing 3 (a)). First, Cr (chromium) and Au(gold) are formed with vacuum deposition all over the Ath page of a ceramic substrate 101. At this time, Cr raises the adhesion of a ceramic substrate 101 and Au, and forms Cr ahead of Au. After forming Au/Cr, the stationary-contact layers 106a, 106b, 107a, and 107b are created by etching (it is described as etching below.) according an Au/Cr layer to a photolithography technique (drawing 3 (b)).

[0016] Drawing 5 is drawing having shown gradually the creation approach by the side of Si (silicon single crystal wafer) substrate which consists of a movable piece 108 of the 1st example. The Si substrate 109 used as the above-mentioned movable piece 108 is created in the direction of a field as shown in drawing 6. If the above-mentioned Si substrate 109 is manufactured in the shape of a rectangle, although, as for parallel 602a and 602b, a precise

straight line is obtained to orientation FAZETTO (it is described as Following OF.) 601, the perpendicular sides 602c and 602d will become Giza-like to OF601. However, if the above-mentioned Si substrate 109 is manufactured in the slanting direction of a field to the above OF601, the above-mentioned Si substrate 109 of the others shown in drawing 6 which serves as a configuration of the shape of 603a, 603b, 603c, and Giza where 603d is complicated, and requires a precise configuration will be hard to be obtained four sides.

[0017] Then, it manufactures so that four sides of the Si substrate 109 may be set to 602a, 602b, 602c, and 602d, and SiO₂(silicon oxide) 110a and 110b are formed for example, by the oxidizing [thermally] method to the Ath page of the Si substrate 109 first shown in drawing 5, and the Bth page (drawing 5 (a)). After forming SiO₂, SiO₂ of Bth above-mentioned page 2110b is etched, and removal processing of the perimeter frame is left and carried out (drawing 5 (b)). Specified quantity removal processing of within the limit [perimeter] is carried out for the Si substrate 109 to this Bth page by KOH (potassium hydroxide) anisotropic etching by using SiO₂110b as a mask (drawing 5 (c)).

[0018] Next, Cr111 and Au(gold)112 are formed all over the Ath page with vacuum deposition. At this time, Cr raises the adhesion of SiO₂ and Au and forms Cu ahead of Au. The traveling contact layers 112a and 112b are formed in the piece of an edge of the part which etches a Cr/Au layer using an aqua regia (hydrochloric acid: nitric acid : 3:1 volume ratios), and serves as the above-mentioned movable pieces 108a and 108b. the whole surface of the Ath page of after that — the permalloy film 113 (alloy of nickel and iron) — for example, membranes are formed with vacuum deposition thinly about 300Å (drawing 5 (d)). Next, a resist 114 is formed with vacuum deposition on the permalloy film 113 of the whole surface of the Ath above-mentioned page.

[0019] Adsorption **** 116a and 116b are formed for the above-mentioned resist 114 by adhesion exposure with the ***** form of the contact surface of the above-mentioned electromagnetic magnets 102a and 102b. Then, the permalloy film 115 is thickly formed with vacuum deposition equally [about 12 microns] all over the Ath above-mentioned page (drawing 5 (e)).

[0020] In addition, this permalloy film 113,115 is NiSO₄·6H₂O (nickel sulfate)... It is 150gFeSO₄·7H₂O (iron sulfate)..... It is 10gH₃BO₄ (boric acid). 20g saccharin What mixed 0.75g is used.

[0021] Next, adsorption **** 116a and 116b formed by the resist 114 on the Ath above-mentioned page are covered by Resists 117a and 117b, and the permalloy film 113,115 from which a nitric acid, hydrogen peroxide solution, and water serve as outside the limit [of the Ath page / adsorption section] with the etching reagent of 2.9:1:7.2 is etched and removed (drawing 5 (f)). Next, adhesion exposure removes altogether these resists 114,117a and 117b of the Ath page, and the adsorption sections 115a and 115b are formed. And it forms in the form which etched into the configuration where the KO character countered SiO₂ of Ath page 2,110a, only the predetermined amount finally etched with a potassium hydroxide solution, and the movable pieces 108a and 108b connected to the perimeter frame through the pivotable support section 118 (drawing 5 (g)). Si substrate side 109 processed as mentioned above and ceramic substrate side 101 are pasted up through a spacer 119.

[0022] Next, actuation of an electromagnetic relay of the 1st example is explained. If direct current voltage is impressed to coil 104of electromagnetic magnet 102a a, magnetomotive force will occur in this electromagnetic magnet 102a, piece section of before movable piece 108 108a uses the pivotable support section 118 as the supporting point, in order to bend and displace to the electromagnetic magnet 102a side, traveling contact layer 112a will contact the stationary-contact layers 106a and 106b, and between both stationary-contacts layer 106a and 106b will be closed.

[0023] If impression of the above-mentioned direct current voltage is severed, movable piece 108A will return to the original state by the torsion return force of the pivotable support section 118, and between both stationary-contacts layer 106a and 106b will be opened wide. Piece section of after movable piece 108 108b also performs the same actuation as the above by impressing direct current voltage to coil 104of electromagnetic magnet 102b b. Although remnant

magnetism remains in the above-mentioned electromagnetic magnets 102a and 102b slightly at the adsorption sections 115a and 115b after impressing and disconnecting direct current voltage, there is an electromagnetic relay of the 2nd example as a means which removes this.

[0024] Drawing 7 is the important section cross-section decomposition perspective view of an electromagnetic relay of the 2nd example. Drawing 8 is the B-B line sectional view of drawing 7. Drawing 9 is drawing having shown gradually the creation approach by the side of Si substrate which consists of a movable piece 208. SiO₂(silicon oxide) 210a and 210b are first formed by the oxidizing [thermally] method to the Ath page of the Si substrate 209, and the Bth page (drawing 9 (a)). After forming SiO₂, SiO₂ of Bth above-mentioned page 210b is etched, and removal processing of the perimeter frame is left and carried out (drawing 9 (b)). Specified quantity removal processing of within the limit [perimeter] is carried out for the Si substrate 209 to this Bth page by KOH (potassium hydroxide) anisotropic etching by using SiO₂ 210b as a mask (drawing 9 (c)).

[0025] Next, the detailed coils 114a and 114b are formed in the Ath page part of the Si substrate 209 which counters the above-mentioned electromagnetic magnets 102a and 102b. the above -- as a processing means of a detailed coil, Nb (niobium) is formed with vacuum deposition all over the Ath page of the 1Si substrate 209.

2) Attach a copper plate 214 to the Ath page part of the Si substrate 209 which counters the above-mentioned electromagnetic magnets 102a and 102b with vacuum deposition after forming Nb. At this time, Nb is used in order to raise SiO₂ 210a and copper plate 214 adhesion.

3) Process this copper plate 214 on a fault volume by etching, and form the detailed coils 214a and 214b, after attaching a copper plate 214.

After forming the detailed coils 214a and 214b, polyimide (resin) 215 is attached all over the Ath page, and the detailed coils 214a and 214b are fixed to the Si substrate 209 (drawing 9 (b)). In order to pull out the piece of an edge of the core of the above-mentioned coils 214a and 214b out of this coil, etching removes the polyimide 215 of the piece part of an edge of the core of the 1 above-mentioned coils 214a and 214b.

2) Form Nb with vacuum deposition all over the Ath page of Si *****.

3) Attach the small copper plates 216a and 216b of two sheets with vacuum deposition in the configuration which processed into the Ath page of the Si substrate 209, and was put on the fixed detailed coils 214a and 214b.

4) And process the above-mentioned copper plates 216a and 216b by etching, and form the piece of an edge which exists at the core of the above-mentioned coils 214a and 214b so that it may become an outgoing line other than this coil.

Special processing is carried out as mentioned above, and outgoing lines 216a and 216b are formed (drawing 9 (e)). After forming outgoing lines 216a and 216b, polyimide 217 is attached all over the Ath page, and outgoing lines 216a and 216b are fixed to the Si substrate 209. Next, only above-mentioned coil 214a and a 214b part leave the above-mentioned polyimide 217 by etching, and it removes. (Drawing 9 (f)) . Next, Cr 219 and Au(gold) 218 are formed all over the Ath page with vacuum deposition. At this time, Cr raises the adhesion of SiO₂ and Au and forms Cu ahead of Au. The traveling contact layers 218a and 218b are formed in the piece of an edge of the part which etches a Cr/Au layer using an aqua regia (hydrochloric acid: nitric acid : 3:1 volume ratios), and serves as the above-mentioned movable pieces 208a and 208b.

[0026] the whole surface of the Ath page of after that -- the permalloy film 220 (alloy of nickel and iron) -- for example, membranes are formed with vacuum deposition thinly about 300Å (drawing 9 (g)).

[0027] Next, a resist 221 is formed with vacuum deposition on the entire permalloy film 220 of the Ath above-mentioned page. Adsorption **** 223a and 223b are formed for the above-mentioned resist 221 by adhesion exposure with the ***** form of the contact surface of the above-mentioned electromagnetic magnets 102a and 102b. Then, except for the resist 221 of the Ath above-mentioned page, the permalloy film 222 is thickly formed with vacuum deposition equally [about 12 microns] (drawing 10 (h)).

[0028] In addition, this permalloy film 220, 222 is NiSO₄·6H₂O (nickel sulfate)... It is 150gFeSO₄·7H₂O (iron sulfate)..... It is 10gH₃BO₄ (boric acid). 20g saccharin What mixed

0.75g is used.

[0029] Next, the resist 221 of adsorption **** 223a and 223b formed on this Ath page is covered by Resists 224a and 224b, and after that, for example, a nitric acid, hydrogen peroxide solution, and water etch the permalloy film 220,222 of an adsorption section outside the limit of the Ath page with the etching reagent of 2.9:1:7.2, and it removes (drawing 10 (i)).

[0030] Next, adhesion exposure removes altogether these resists 221,224a and 224b of the Ath page, and the adsorption sections 223a and 223b are formed (drawing 10 (j)). And it forms in the form which etched into the configuration where the KO character countered SiOof Ath page2210a, only the predetermined amount finally etched with a potassium hydroxide solution, and the movable pieces 208a and 208b connected to the perimeter frame through the pivotable support section 225 (drawing 10 (k)). Si substrate side 209 processed as mentioned above is pasted up through ceramic substrate side 101 and a spacer 119.

[0031] Next, actuation of an electromagnetic relay of the 2nd example is explained. If direct current voltage is impressed to coil 104of electromagnetic magnet 102a a, magnetomotive force will occur in this electromagnetic magnet 102a, piece section of before movable piece 208 208a uses the pivotable support section 225 as the supporting point, in order to bend and displace to the electromagnetic magnet 102a side, traveling contact layer 218a will contact the stationary-contact layers 106a and 106b, and between both stationary-contacts layer 106a and 106b will be closed.

[0032] After refusing impression of the above-mentioned direct current voltage for opening between both above-mentioned stationary-contacts layer 106a and 106b, it is required to remove the remnant magnetism which remained in permalloy film 222a used as adsorption section 223of piece section of above front 208a a. Then, after refusing impression of the above-mentioned direct current voltage first, direct current voltage was made to impress to coil 214a laid under the above-mentioned movable piece 208 temporarily, and the remnant magnetism of the above-mentioned adsorption section 223a was removed. Front piece section 208a returns to the original state by the torsion return force of the pivotable support section 225, and between both stationary-contacts layer 106a and 106b is opened wide. By impressing direct current voltage to coil 104of electromagnetic magnet 102b b, piece section of after movable piece 208 208b also performs the same actuation as the above.

[0033] Drawing 11 is the important section cross-section perspective view of an electromagnetic relay of the 3rd example. Drawing 12 is the C-C line sectional view of drawing 11. Drawing 13 is the expanded sectional view of electromagnetic magnet 302a made to insert in the through hole of the ceramic substrate of drawing 11. A magnet is attached and formed in the adsorption sections 315a and 315b on the Si substrate 309 which counters the electromagnetic magnets 302a and 302b in this example. In addition, the structure of a part is the same as that of an electromagnetic relay of the 1st example.

[0034] Next, actuation of an electromagnetic relay of the 3rd example is explained.

[0035] If the direct current voltage of a negative electrode (-: minus) is impressed in the direction of A from a positive electrode (+: plus) among drawing to coil 304of electromagnetic magnet 302a of structure of U character mold a Magnetomotive force occurs in this electromagnetic magnet 302a, ***** of electromagnetic magnet 302a countered and arranged in the adsorption section N pole of piece section of before movable piece 308 308a serves as the south pole, and one ***** which was countered and arranged in this adsorption section south pole and which will said electromagnetic magnet 302a Accept it serves as N pole. In order that movable piece 308a may bend and displace the pivotable support section 318 to the electromagnetic magnet 302a side with the attraction between the unlike poles which faced each other as the supporting point, traveling contact layer 312a contacts the stationary-contact layers 306a and 306b, and Kaisei of between both stationary-contacts layer 306a and 306b is carried out.

[0036] The direct current voltage of a negative electrode (-: minus) is impressed to opening between both above-mentioned stationary-contacts layer 306a and 306b from a positive electrode (+: plus) in the direction of B to 304of above-mentioned electromagnetic magnet 302a a. With the above, the magnetomotive force to hard flow is occurred in this electromagnetic

magnet 302a. ***** of electromagnetic magnet 302a arranged to the adsorption section N pole of piece section of before movable piece 308 308a serves as N pole, and this adsorption section south pole is countered. One arranged ***** which will said electromagnetic magnet 302a Accept it serves as the south pole, movable piece 308a separates from electromagnetic magnet 302a according to the repulsive force between the unlike poles which faced each other considering the pivotable support section 318 as the supporting point, and both the stationary-contacts layers 306a and 306b are opened wide. Piece section of after movable piece 308 308b also performs the same actuation as the above by impressing direct current voltage to coil 304 of electromagnetic magnet 302b b to compensate for actuation of a relay. The electromagnetic magnets 102a and 102b inserted in the through holes 105a and 105b of the ceramic substrate 101 shown in drawing 1 in the 3rd example are made to counter, and actuation with the same said of the configuration of one adsorption section of N pole or the south pole is considered in the magnet of the adsorption sections 315a and 315b on the Si substrate 309.

[0037]

[Effect of the Invention] Since he is trying to use magnetomotive force as a driving source moreover, while being able to obtain big driving force as compared with the former taking advantage of the description of the conventional micro relay according to this invention, contact force becomes large and the stability of a relay can increase.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the decomposition perspective view of an electromagnetic relay of the 1st example.

[Drawing 2] It is the A-A line sectional view of drawing 1.

[Drawing 3] It is drawing having shown gradually the creation approach by the side of a ceramic substrate.

[Drawing 4] It is the expanded sectional view of the electromagnetic magnet made to insert in the through hole by the side of the ceramic substrate of drawing 3.

[Drawing 5] It is drawing having shown gradually the creation approach by the side of Si (silicon single crystal wafer) substrate which consists of a movable piece of the 1st example.

[Drawing 6] It is the explanatory view of the direction of a field of a silicon single crystal wafer.

[Drawing 7] It is the decomposition perspective view of an electromagnetic relay of the 2nd example.

[Drawing 8] It is the B-B line sectional view of drawing 7.

[Drawing 9] It is drawing having shown gradually the creation approach (a-g) by the side of Si (silicon single crystal wafer) substrate which consists of a movable piece of the 2nd example.

[Drawing 10] It is drawing having shown gradually the creation approach (h-k) by the side of Si (silicon single crystal wafer) substrate which consists of a movable piece of the 2nd example.

[Drawing 11] It is the important section cross-section perspective view of an electromagnetic

relay of the 3rd example.

[Drawing 12] It is the C-C line sectional view of drawing 11 .

[Drawing 13] It is the expanded sectional view of the electromagnetic magnet made to insert in the through hole by the side of the ceramic substrate of drawing 11 .

[Drawing 14] It is the decomposition perspective view of the electrostatic relay in which conventional micro Massine's example is shown.

[Drawing 15] It is the A-A line sectional view of drawing 14 .

[Description of Notations]

101 Ceramic Substrate

102a, 102b Electromagnetic magnet

103a, 103b Core

104a, 104b Coil (copper wire)

105a, 105b Through hole

106a, 106b Stationary-contact layer

107a, 107b Stationary-contact layer

108a, 108b Movable piece

109 Si Substrate

110a, 110b SiO₂ (silicon oxide)

112a, 112b Traveling contact layer

115a, 115b Adsorption section (magnetic substance)

118 Pivotal Support Section

119 Spacer

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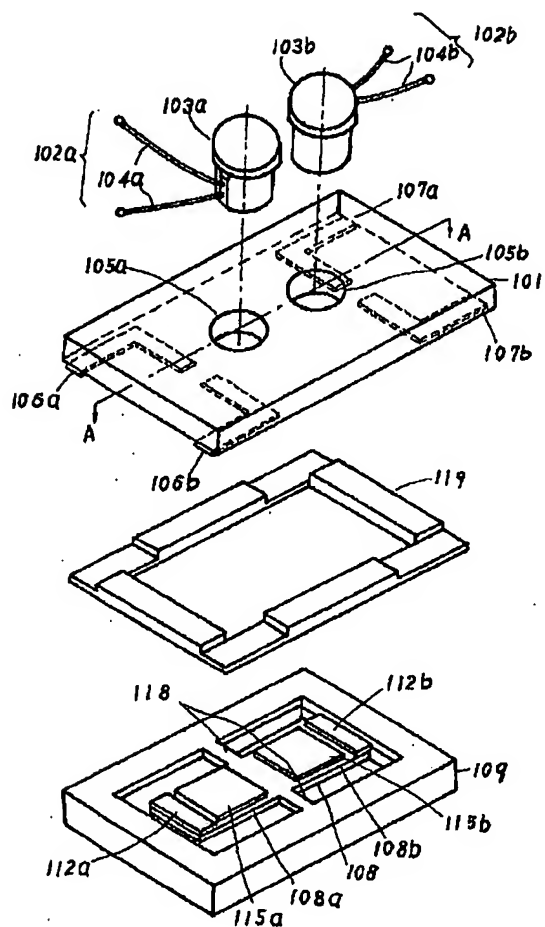
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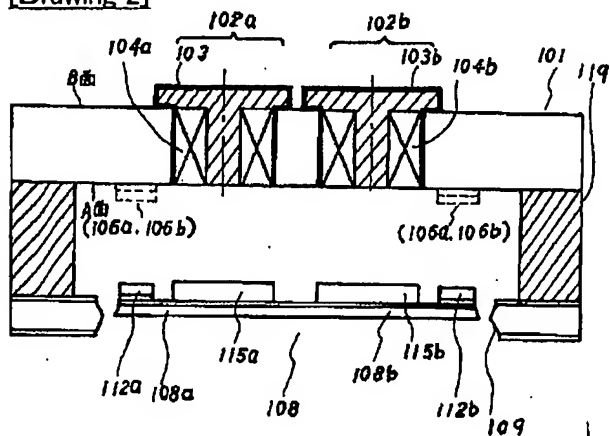
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DRAWINGS

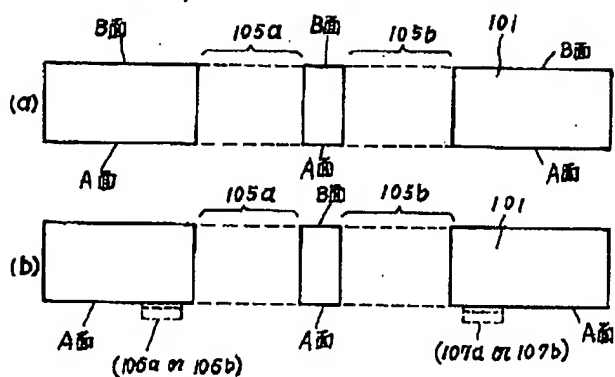
[Drawing 1]



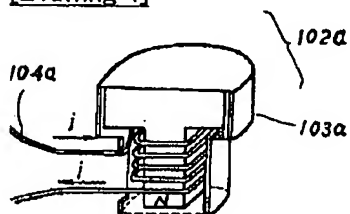
[Drawing 2]



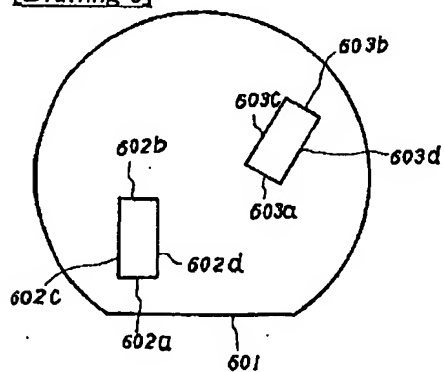
[Drawing 3]



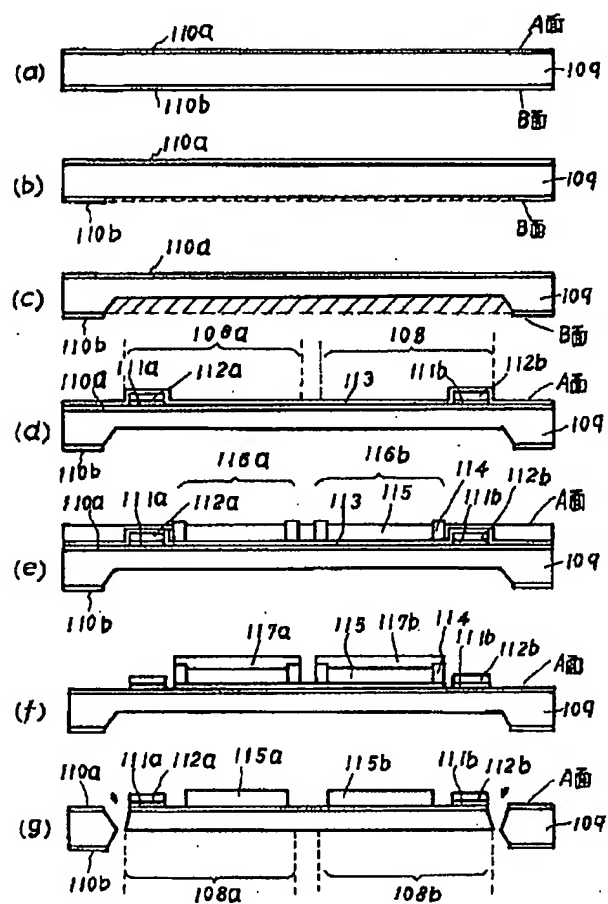
[Drawing 4]



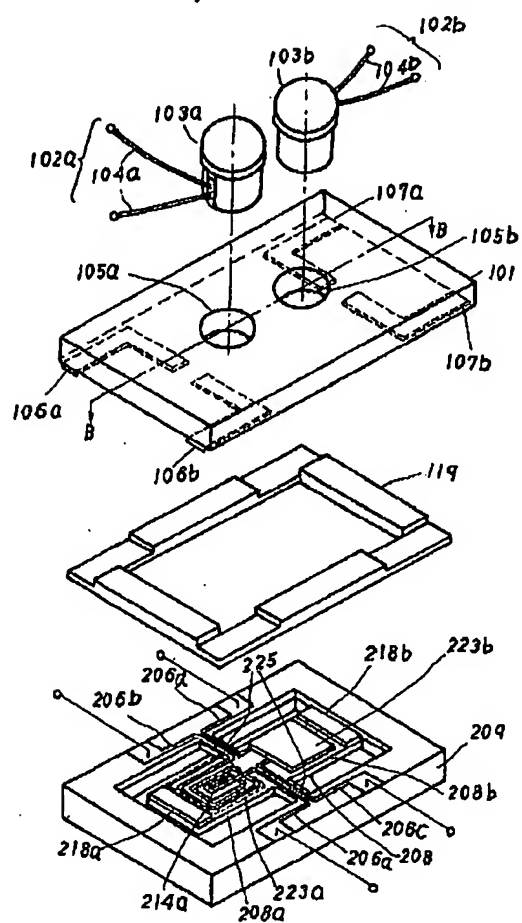
[Drawing 6]



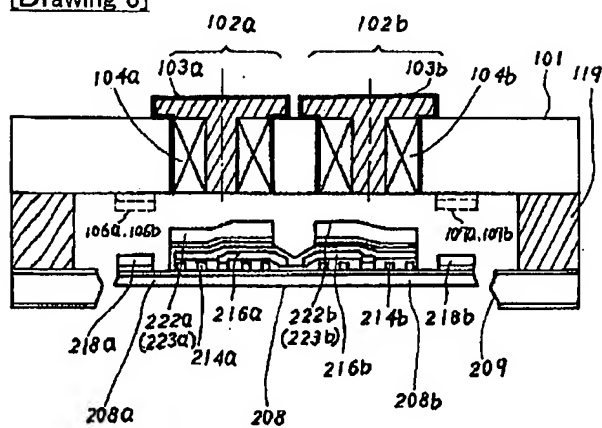
[Drawing 5]



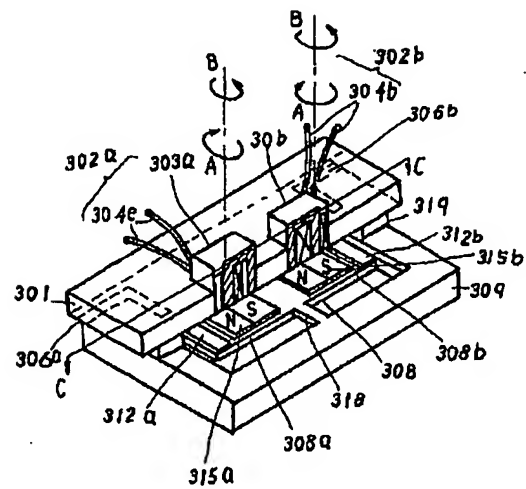
[Drawing 7]



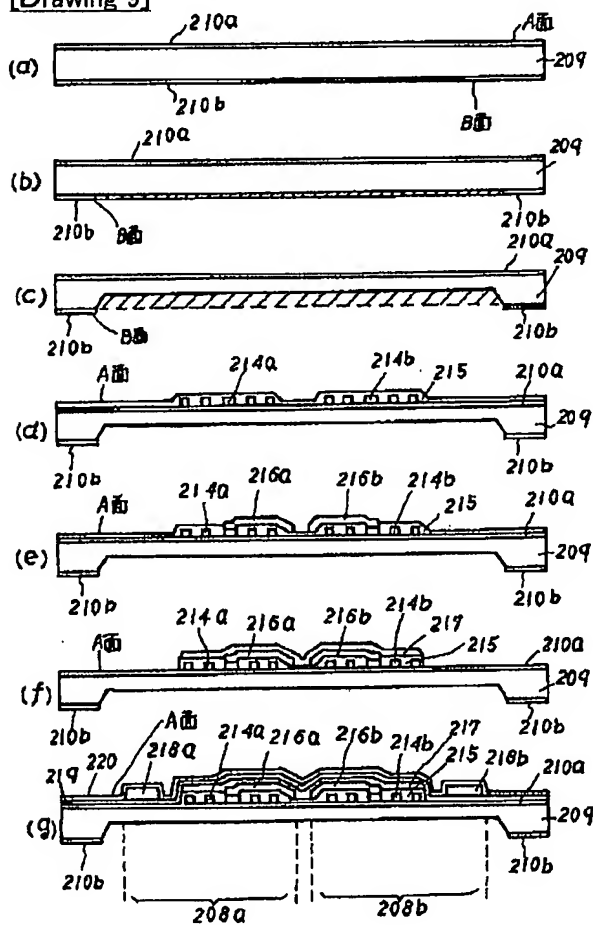
[Drawing 8]



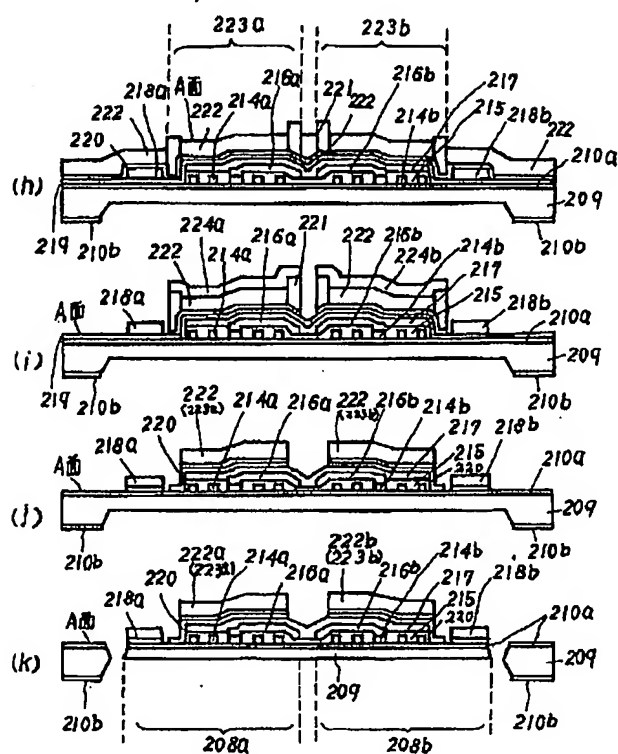
[Drawing 11]



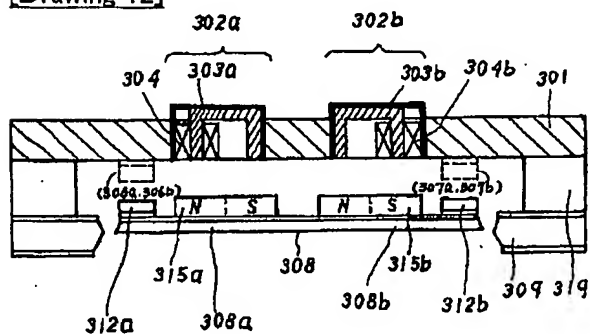
[Drawing 9]



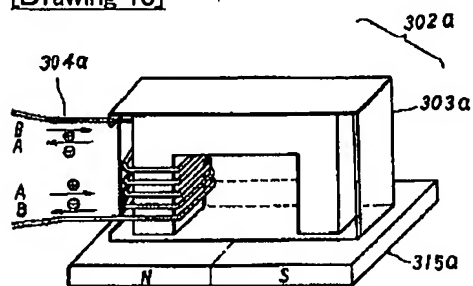
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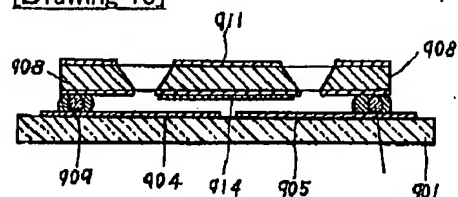
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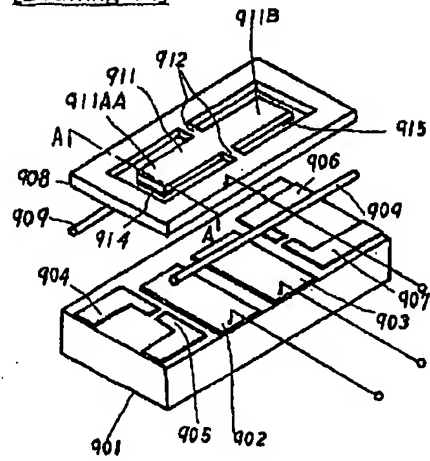
[Drawing 13]



[Drawing 15]



[Drawing 14]



[Translation done.]

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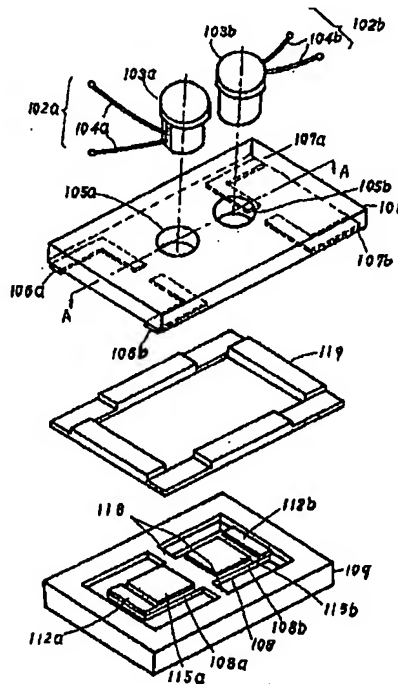
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(54)【発明の名称】 電磁式リレー

(57) 【要約】

【目的】 電磁式マグネットに直流電圧を印加すること
で起こる起磁力を駆動源とすることにより、従来のマイ
クロリレーよりも大きな駆動力の得られるマイクロリ
レーを提供することにある。

【構成】 電気絶縁体の基板に設けた電磁式マグネットと、上記電磁式マグネットを設けたこの基板主面にスパーサ手段を介して対向配設された可動する半導体単結晶からなる可動片とで機械要素を構成し、上記電磁式マグネットに対向する上記可動片の表面に磁性体で形成された吸着部と、上記可動片に絶縁薄膜を介して形成された可動接点層と、上記電気絶縁体の基板の主面に形成されて上記可動接点層で開閉される固定接点層とを備えたことを特徴とする電磁式リレー。



【特許請求の範囲】

【請求項1】 電気絶縁体の基板に設けた電磁式マグネットと、上記電磁式マグネットを設けたこの基板主面にスペーサ手段を介して対向配設された可動する半導体単結晶からなる可動片とで機械要素を構成し、

上記電磁式マグネットに対向する上記可動片の表面に磁性体で形成された吸着部と、

上記可動片に絶縁薄膜を介して形成された可動接点層と、上記電気絶縁体の基板の主面に形成されて上記可動接点層で開閉される固定接点層とを備えたことを特徴とする電磁式リレー。

【請求項2】 上記可動片と上記吸着部との間に微細なコイルを埋設してなることを特徴とする請求項1記載の電磁式リレー。

【請求項3】 上記吸着部は、磁石を用いて形成されたことを特徴とする請求項1記載の電磁式リレー。

【発明の詳細な説明】

【0001】

【産業上の利用分野】この発明はマイクロマシンの1つであり、起磁力を駆動源とする電磁式リレーに関する。

【0002】

【従来の技術】従来マイクロマシンの1つに静電吸引力を駆動源とする静電式リレーがある。

【0003】この静電式リレーは一例として特開平2-100224号に開示されている。図14は従来の静電式リレーの分解斜視図である。図15は図14のA-A線断面図である。

【0004】この静電式リレーの動作について説明する。可動片911と前側の固定電極層902との間に直流電圧を印加すると、可動片911の前片部911Aと上記電極層902との間に静電吸引力が生起し、前片部911Aは枢支部912を支点として電極層902側へ歪んで変位するため、可動接点層914が固定接点層904、905に接触し、両固定接点層904、905間が開成される。上記直流電圧の印加を断つと、可動片911Aは枢支部912のねじれ復帰力で原状に復帰し、両固定接点層904、905間が開放される。

【0005】可動片911と後側の固定電極層903との間に直流電圧を印加することにより、可動片911の後片部911Bも上記と同様の動作を行なう。

【0006】ここで、可動片911をシリコン単結晶ウエハ908から形成すれば微細加工が可能となる。さらに、上記可動片911を基体901とは別体のシリコン単結晶ウエハ908から形成したから、スペーサ909の選択によって電極間距離を変えて所望の駆動力を得ることができる。

【0007】

【発明が解決しようとする課題】しかしながら、上記図14に上げた微細加工による静電式リレーでは上記可動

接点層914が上記固定接点層904、905に接触し、両固定接点層904、905間をON、OFF制御をするために上記固定電極層902、903と上記可動片911とで構成した駆動用対向電極間に所定の静電吸引力を生起させることが必要である。また、対向する上記電極間の隙間を小さくする必要があるが非常にこの隙間を小さくすると短絡する危険性があるため、実状特定の大きさ以下には作製できない。

【0008】そこで本発明の目的は電磁式マグネットに直流電圧を印加することで起こる起磁力を駆動源とすることにより、従来のマイクロリレーよりも大きな駆動力の得られるマイクロリレーを提供することにある。

【0009】

【課題を解決するための手段】前記目的を達成するために本発明の請求項1に係る電磁式リレーは、電気絶縁体の基板に設けた電磁式マグネットと、上記電磁式マグネットを設けたこの基板主面にスペーサ手段を介して対向配設された可動する半導体単結晶からなる可動片とで機械要素を構成し、上記電磁式マグネットに対向する上記可動片の表面に磁性体で形成された吸着部と、上記可動片に絶縁薄膜を介して形成された可動接点層と、上記電気絶縁体の基板の主面に形成されて上記可動接点層で開閉される固定接点層とを備えたことを特徴としている。請求項2に係る電磁式リレーは、上記可動片と上記吸着部との間に微細なコイルを埋設してなることを特徴としている。請求項3に係る電磁式リレーは、上記吸着部に磁石を用いて形成されたことを特徴としている。

【0010】

【作用】本発明の請求項1の構成によれば駆動源となる起磁力が生起する電磁式マグネットとこの電磁式マグネットを設けた基板主面对向して配設された可動する可動片の表面に磁性体で形成された吸着部を設ける。上記電磁式マグネットに直流電圧を印加することで起こる起磁力を持って上記可動片を撓ませ、上記電磁式マグネットに上記可動片を吸着する。すると、上記可動片に別途形成された可動接点層で上記基板主面に形成された固定接点層を開閉することができる。

【0011】本発明の請求項2の構成によれば特殊加工により上記可動片と上記吸着部との間に微細なコイルを埋設する。上記電磁式マグネットに直流電圧を印加、切断した後わずかに上記吸着部に残留磁気が残るが、上記可動片に埋設された上記コイルに直流電圧を、一時的に印加して上記吸着部の残留磁気を取り除くことができる。

【0012】本発明の請求項3の構成によれば上記吸着部は磁石を用いて形成する。常に上記電磁式マグネットに直流電圧を印加しておけばこの電磁式マグネットは電磁石として使える。上記電磁式マグネットのコイルに流す電流の向きを変えることによって上記電磁式マグネットの極性(N極・S極)を切り替えることができる。す

ると、上記電磁式マグネットに可動片を吸着したり、反発したりすることができる。

【0013】

【実施例】本発明の一実施例を図面を参照して説明する。図1は第1の実施例の電磁式リレーの分解斜視図である。図2は図1のA-A線断面図である。図3はセラミック基板側101の作成方法を段階的に示した図であり、図4は図3のセラミック基板101の貫通穴に挿設させた電磁式マグネット102aの拡大断面図である。

【0014】電磁式マグネット102a、102bはコア103a、103bとコイル（銅線）104a、104bから成っている。コア103a、103bは例えばMn（マンガン）-Zn（ジンク）フェライトを粉体にして金型に入れて固め、焼成することによって作成し、コイル104a、104bはコア103a、103bの中の芯のまわりに例えば周りを絶縁物で被覆された0.1mmの銅線により約30ターンずつ巻いて作成する。

【0015】セラミック基板101は例えばAl₂O₃（アルミナ）の粉体を金型に入れて固め焼成することによって作成する。セラミック基板101には、貫通穴105a、105bが設けられている（図3（a））。まず、セラミック基板101のA面の全面にCr（クロム）とAu（金）を真空蒸着により成膜する。このときCrはセラミック基板101とAuの密着性を向上させるものでAuより先にCrを成膜する。Au/Crを成膜した後、Au/Cr層をフォトリソグラフィ技術によるエッチング（以下エッチングと記す。）により固定接点層106a、106b、107a、107bを作成する（図3（b））。

【0016】図5は第1の実施例の可動片108からなるSi（シリコン単結晶ウエハ）基板側の作成方法を段階的に示した図である。上記可動片108となるSi基板109は例えば図6に示すような面方向に作成する。上記Si基板109を矩形状に製作すると、オリエンテーション・ファセット（以下OFと記す。）601に対して平行な602a、602bは、精密な直線が得られるもののOF601に対して垂直な辺602c、602dはギザ状となる。しかし、上記OF601に対して斜めの面方向に上記Si基板109を製作すると図6に示す他の4辺603a、603b、603c、603dは複雑なギザ状の形状となり、精密な形状を要求する上記Si基板109は得られにくい。

【0017】そこでSi基板109の4辺が602a、602b、602c、602dとなるように製作して、まず図5に示すSi基板109のA面及びB面に例えば熱酸化法によりSiO₂（酸化シリコン）110a、110bを成膜する（図5（a））。SiO₂を形成した後、上記B面のSiO₂110bをエッチングし、周囲枠を残して除去加工する（図5（b））。このB面にSiO₂110bをマスクとしてSi基板109をKOH

（水酸化カリウム）異方性エッチングにより周囲枠内を所定量除去加工する（図5（c））。

【0018】次にCr111とAu（金）112を真空蒸着によりA面の全面に成膜する。この時、CrはSiO₂とAuとの密着性を向上させるものでAuより先にCuを成膜する。Cr/Au層を例えば王水（塩酸：硝酸：3：1の容積比）を用いてエッチングして上記可動片108a、108bとなる部分の端片に可動接点層112a、112bを形成する。その後A面の全面にパーマロイ膜113（ニッケルと鉄の合金）を例えば300オングストローム程薄く真空蒸着により成膜する（図5（d））。次に上記A面の全面のパーマロイ膜113に真空蒸着によりレジスト114を成膜する。

【0019】上記レジスト114を密着露光により上記電磁式マグネット102a、102bの接触面のふちどった形で吸着部枠116a、116bを形成する。その後、上記A面の全面に厚くパーマロイ膜115を例えば12ミクロン程度均等に真空蒸着により成膜する（図5（e））。

【0020】尚、このパーマロイ膜113、115は例えば

NiSO ₄ ・6H ₂ O（硫酸ニッケル）	・・・150g
FeSO ₄ ・7H ₂ O（硫酸鉄）	・・・10g
H ₂ BO ₃ （硼酸）	・・・20g
サッカリン	・・・0.75g

を混合したものを用いる。

【0021】次に上記A面上のレジスト114で形成された吸着部枠116a、116bをレジスト117a、117bで覆い、そして、例えば硝酸、過酸化水素水、水が2：9：1：7.2のエッチング液によりA面の吸着部枠外となるパーマロイ膜113、115をエッチングして除去する（図5（f））。次にこのA面のレジスト114、117a、117bを密着露光によりすべて除去して、吸着部115a、115bを形成する。そしてA面のSiO₂110aにコ字が対向した形状にエッチングを行ない、最後に例えば水酸化カリウム溶液により所定の量だけエッチングを行なって可動片108a、108bが枢支部118を介して周囲枠に接続した形に形成する（図5（g））。上記のように加工されたSi基板側109とセラミック基板側101とはスペーサ119を介し接合する。

【0022】次に第1の実施例の電磁式リレーの動作について説明する。電磁式マグネット102aのコイル104aに直流電圧を印加すると、この電磁式マグネット102aに起磁力が生じ、可動片108の前片部108aは枢支部118を支点として電磁式マグネット102a側へ撓んで変位するため、可動接点層112aが固定接点層106a、106bに接触し両固定接点層106a、106b間が開成される。

【0023】上記直流電圧の印加を断つと、可動片10

8Aは枢支部118のねじれ復帰力で原状に復帰し、両固定接点層106a、106b間が開放される。電磁式マグネット102bのコイル104bに直流電圧を印加することにより可動片108の後片部108bも上記と同様の動作を行う。上記電磁式マグネット102a、102bに直流電圧を印加・切断した後、わずかに吸着部115a、115bに残留磁気が残るが、これを取り除く手段として第2の実施例の電磁式リレーがある。

【0024】図7は第2の実施例の電磁式リレーの要部断面分解斜視図である。図8は図7のB-B線断面図である。図9は可動片208からなるSi基板側の作成方法を段階的に示した図である。まずSi基板209のA面及びB面に熱酸化法によりSiO₂（酸化シリコン）210a、210bを成膜する（図9（a））。SiO₂を形成した後、上記B面のSiO₂210bをエッチングし、周囲枠を残して除去加工する（図9（b））。このB面にSiO₂210bをマスクとしてSi基板209をKOH（水酸化カリウム）異方性エッチングにより周囲枠内を所定量除去加工する（図9（c））。

【0025】次に上記電磁式マグネット102a、102bに対向するSi基板209のA面部位に微細なコイル114a、114bを形成する。上記微細なコイルの加工手段としては、

1) Si基板209のA面の全面にNb（ニオブ）を真空蒸着により成膜する。

2) Nbを成膜した後、上記電磁式マグネット102a、102bに対向するSi基板209のA面部位に銅板214を真空蒸着により付ける。この時NbはSiO₂210aと銅板214密着性を向上させるために用いる。

3) 銅板214を付けた後、この銅板214をエッチングにより過巻き上に加工して微細なコイル214a、214bを形成する。

微細なコイル214a、214bを形成した後、A面の全面にポリイミド（樹脂）215を付けSi基板209に微細なコイル214a、214bを固定する（図9（b））。上記コイル214a、214bの中心の端片を同コイルの外へ引き出すためには、

1) 上記コイル214a、214bの中心の端片部位のポリイミド215をエッチングにより除去する。

2) Si基板A面の全面にNbを真空蒸着により成膜する。

3) Si基板209のA面に加工し、固定した微細コイル214a、214bに重ねた形状で2枚の小さな銅板216a、216bを真空蒸着により付ける。

4) そして上記コイル214a、214bの中心にある端片を同コイルの外への引き出し線となるように上記銅板216a、216bをエッチングにより加工して形成する。

以上のように特殊加工して引き出し線216a、216

bを形成する（図9（e））。引き出し線216a、216bを形成した後、A面の全面にポリイミド217を付けSi基板209に引き出し線216a、216bを固定する。次にエッチングにより上記ポリイミド217を上記コイル214a、214b部位のみ残して除去する。（図9（f））。次にCr219とAu（金）218を真空蒸着によりA面の全面に成膜する。この時、CrはSiO₂とAuとの密着性を向上させるものでAuより先にCuを成膜する。Cr/Au層を例えば王水（塩酸：硝酸：3：1の容積比）を用いてエッチングして上記可動片208a、208bとなる部分の端片に可動接点層218a、218bを形成する。

【0026】その後A面の全面にパーマロイ膜220（ニッケルと鉄の合金）を例えば300オングストローム程薄く真空蒸着により成膜する（図9（g））。

【0027】次に上記A面の全面のパーマロイ膜220上に真空蒸着によりレジスト221を成膜する。上記レジスト221を密着露光により上記電磁式マグネット102a、102bの接触面のふちどった形で吸着部枠223a、223bを形成する。その後、上記A面のレジスト221を除いて厚くパーマロイ膜222を例えば12ミクロン程度均等に真空蒸着により成膜する（図10（h））。

【0028】尚このパーマロイ膜220、222は例えば、

NiSO ₄ ・6H ₂ O（硫酸ニッケル）	・・・150g
FeSO ₄ ・7H ₂ O（硫酸鉄）	・・・10g
H ₂ BO ₃ （硼酸）	・・・20g
サッカリン	・・・0.75g

30 を混合したものを用いる。

【0029】次にこのA面上に形成された吸着部枠223a、223bのレジスト221をレジスト224a、224bで覆い、その後、例えば硝酸、過酸化水素水、水が2：9：1：7.2のエッチング液によりA面の吸着部枠外のパーマロイ膜220、222をエッチングして除去する（図10（i））。

【0030】次にこのA面のレジスト221、224a、224bを密着露光によりすべて除去して吸着部223a、223bを形成する（図10（j））。そしてA面のSiO₂210aにコ字が対向した形状にエッチングを行い、最後に例えば水酸化カリウム溶液により所定の量だけエッチングを行なって可動片208a、208bが枢支部225を介して周囲枠に接続した形に形成する（図10（k））。上記のように加工されたSi基板側209はセラミック基板側101とスパーサ119を介し接着する。

【0031】次に第2の実施例の電磁式リレーの動作について説明する。電磁式マグネット102aのコイル104aに直流電圧を印加すると、この電磁式マグネット102aに起磁力が生じ、可動片208の前片部20

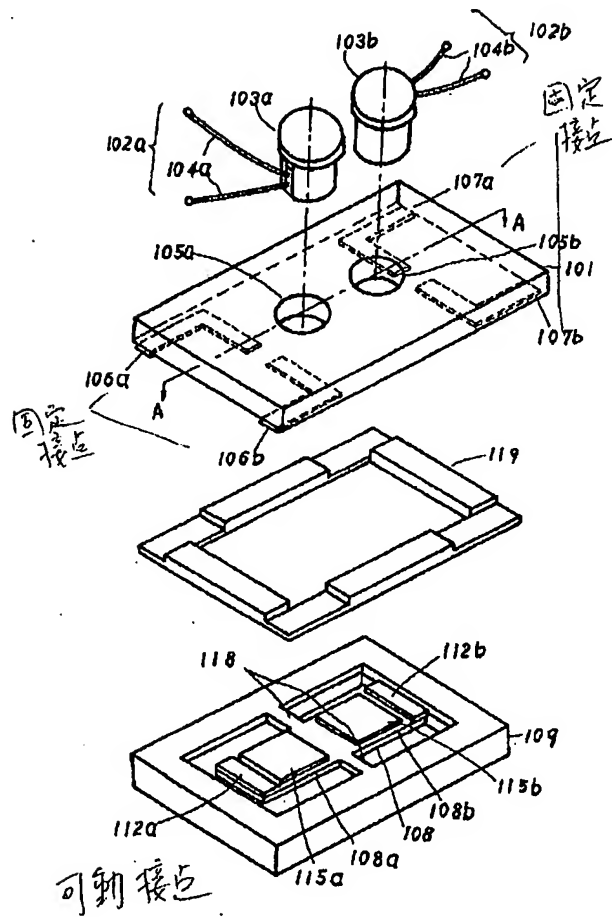
(6)

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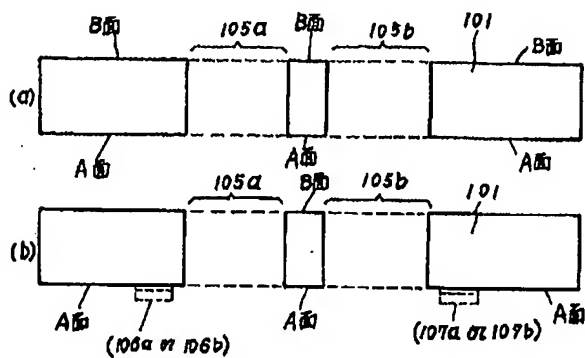
9

105a, 105b 貫通穴
 106a, 106b 固定接点層
 107a, 107b 固定接点層
 108a, 108b 可動片
 109 Si基板

【図1】



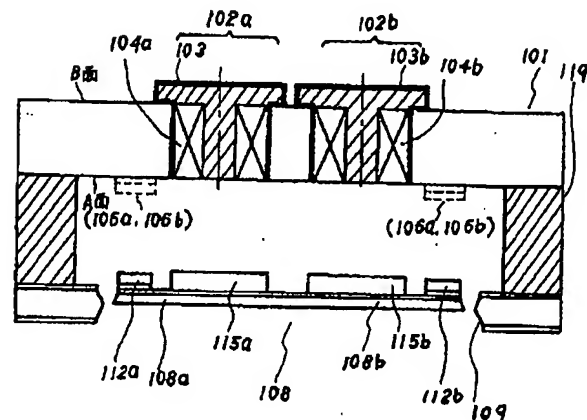
【図3】



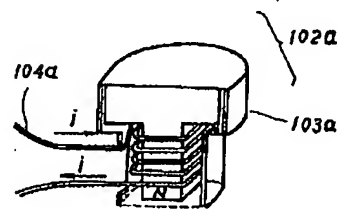
10

* 110a, 110b SiO₂ (酸化シリコン)
 112a, 112b 可動接点層
 115a, 115b 吸着部 (磁性体)
 118 枢支部
 * 119 スペース

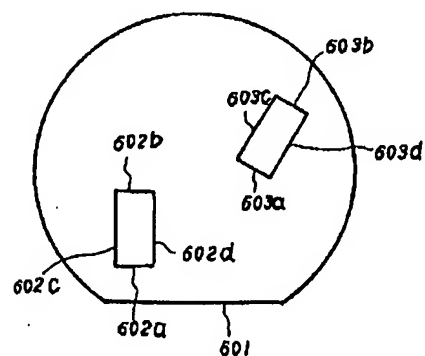
【図2】



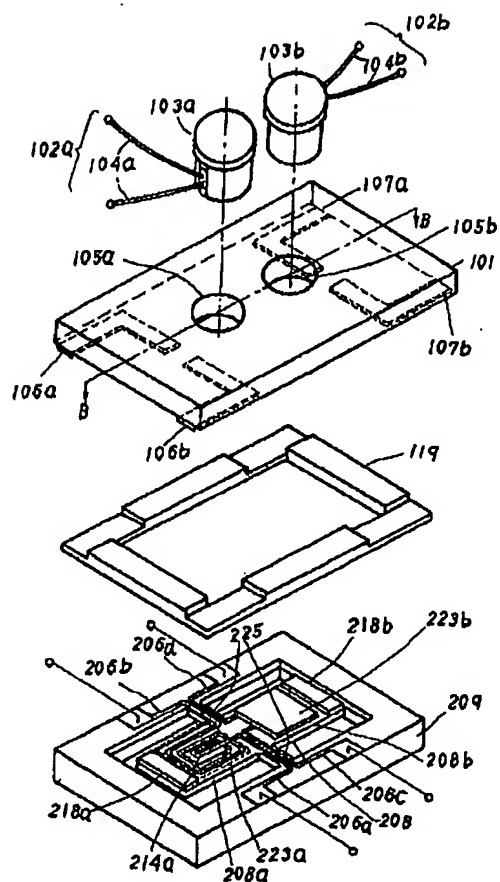
【図4】



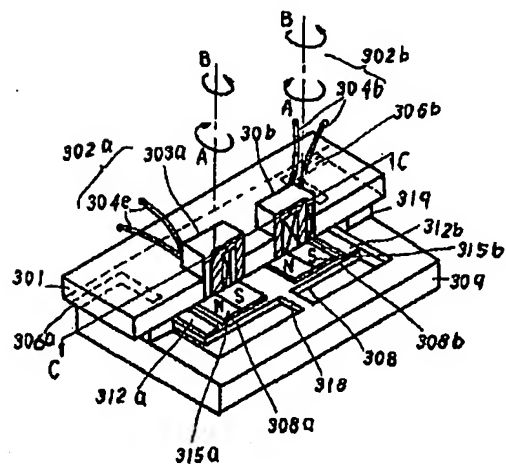
【図6】



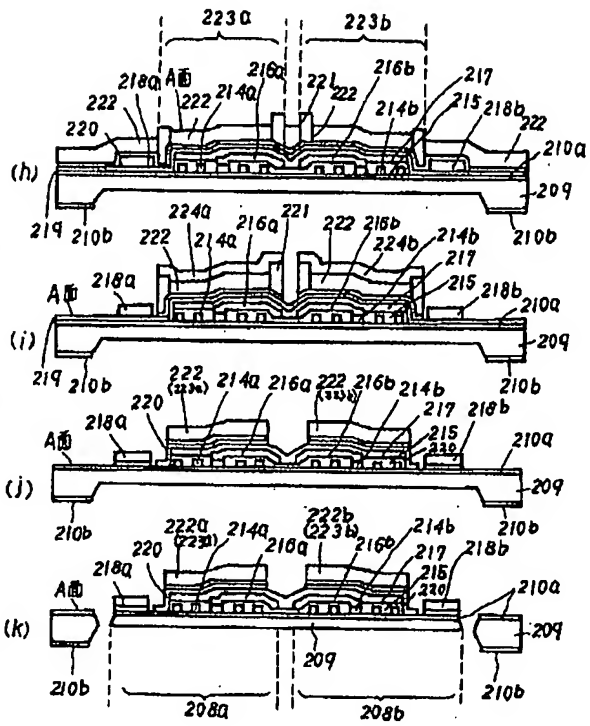
【図 7】



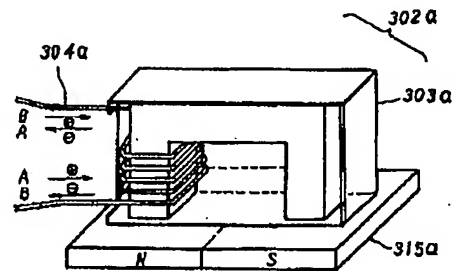
【图 1 1】



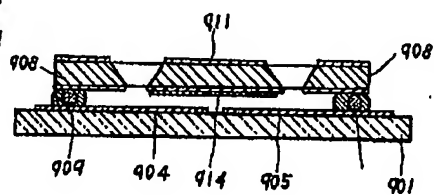
【圖 10】



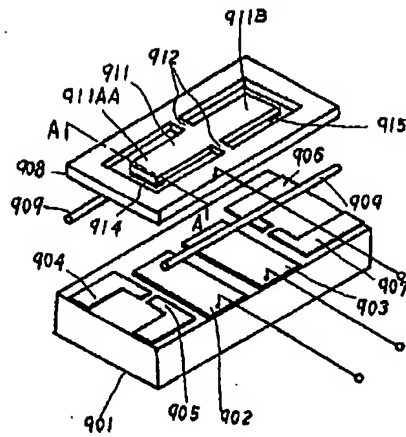
【图 12】



【圖 15】



【図14】



フロントページの続き

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